Indian Dairyman, 31, 6, June 1979, pp. 391-395

Processing and Utilisation of Sour Milk

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■ Milk processing and milk product manufacturing plants commonly face the problem of utilizing sour milk. For our plants this problem is quite unique during summer months unlike the dairy plants of the advanced dairying countries. Souring of milk is attributed to unsatisfactory conditions of milk production and storage, high ambient temperatures, lack of chilling facilities, lack of fast transport due to bad and unapproachable roads and unclean utensils.

De *et al.* (1971) reported that nearly 10,000 tonnes of high acid milk received in different dairies in India is either run into the drains or made use of in the manufacture of products of inferior quality. As a matter of fact, the figures of sour milk from organized and unorganized dairy producers and plants are not available. But it is expected to be in large amounts. The per capita per day consumption of 110 g. of milk in the country warrants the proper utilization of milk constituents even from sour milk. The importance of utilizing sour milk was readily recognized by the Indian Council of Agricultural Research in initiating a scheme under All India Coordinated Research Project (1970-74) to evolve economic methods for the utilization of surplus/substandard milk, (substandard milk included high acid milk also).

A part of milk received at the Raw Milk Reception Dock from the milk producers or the returned unsold milk may be in sour or curdled condition. Skilled technicians can, on smelling and sometimes on testing, reject sour milk from the main processing line to avoid the possible difficulties in processing such milk. They may also perform clot on boiling test, titrable acidity test, developed acidity test, alcohol test, alcohol alizarin test and other heat stability test to confirm the unsuitability of milk for heat processing.

It is difficult to lay any definite parameters in terms of titrable acidity, heat stability or flavour for sour milk. Hunziker (1949) has reported extreme limits of titrable acidity i.e. 0·086 to 0·295 per cent lactic acid in normal milk. Titrable acidities of cow and buffalo bulk milk are reported to be 0·14 and 0·12 per cent lactic acid respectively. The normal acidity is not noticeable to the senses like taste nor it may be affected by heat. The acidity produced by micro-organisms is referred to as Developed Acidity. Milk with more than 0·03% developed acidity is unsuitable for heat processing operation. Cow milk becomes alcohol positive at 0·22 per cent and buffalo milk at 0·19 per cent titrable acidity (Balba *et al.* 1963). Besides lactic acid, volatile substances like acetic acid, formic acid, propionic acid, acetyl methyl carbinol, diacetyl, 2, 3 butylene glycol and carbon-dioxide may be produced during fermentation of milk. Depending on the extent of acid production and the type of microflora in sour milk the above major constituents predominantly interfere in producing desirable flavour in milk products prepared from such milk.

With the production of lactic acid during souring of milk, pH of milk is lowered which in turn primarily affects the water binding property of milk proteins; salt balance is offset resulting in unstable milk for manufacture of milk products utilizing either high or very low temperatures. With the formation

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NDRI Publication No. 79-26.

of lactic acid, the lactose crystals will be less in number in milk products prepared at low temperatures but such products give extreme cold sensation of the tongue. Lactose crystallization along with ice-crystallization in sour milk results in an increase in the amount of free fat. As a result of all these, milk products prepared from sour milk are inferior in body and texture also.

Dairy technologists have therefore, attempted to improve the flavour, body and texture of milk products prepared from sour milk and also tried to improve the heat stability of milk by addition of neutralizers. It may be cautioned here that the prevention of Food Adulteration Act of Government of India does not permit the use of neutralizers in milk and milk products. In the following text the part on neutralization of sour milk and the utilization of sour/neutralizaed milk, is presented.

Neutralization of sour milk

Food grade alkali neutralizers can be used for reducing the acidity in sour milk. Soda as well as lime and magnesium neutralizers are available for this purpose. Soda neutralizers have the distinct advantage that they dissolve readily and are completely soluble in water and their action on the acid in the sour milk is more speedy than that of lime neutralizers. Sommer and Hart (1922) observed the influence of sodium-bicarbonate to be two fold; it has a balancing effect on calcium and it changes the reaction.

The alkali should be dissolved in six to twenty times as much water by weight and added to the milk with sufficient agitation so that no excessive localized overneutralization takes place. The milk temperature may be 35°C less and atleast 15 minutes should be allowed for the reaction before heating.

After the sour milk is neutralized to the normal acidity, it behaves mostly like normal milk as far as heat processing and other operations are concerned. Brownish colour however, develops more rapidly with soda neutralizers during heat processing of such milk. As sodium-bi-carbonate causes foam on a drum milk so treated should not be used for drum drying (Hall and Hedrick, 1971). A sodium type such a sodium hydroxide is preferred for products requiring a maximum solubility.

Processing of milk

Sour milk begins to clot at pasteurization temperature (63 to 70°C) when the titrable acidity is about 0·32 per cent, although deposits are formed at much lower acidity, so that the practical limit for pasteurization is about 0·22 per cent (Devi, 1963).

Roeder and Holne (1953) reported of mixtures of fresh and sour milk in varying proportions from which it is possible to calculate the amount of sour milk that can be added to fresh milk without causing coagulation on pasteurization. Ramanauskas *et al.* (1970) recommended holder pastuerization for processing of milk of increased acidity.

Claerson *et al.* (1974) confirmed that deposit formation in UHT-Sterilizer in case of milk of low ethanol stability could be prevented by adjusting its pH to 6·9, but this increased the non-protein nitrogen (NPN) content in UHT-sterilized milk.

More work and sincere efforts are required to see the feasibility of supplying neutralized milk as market milk at lower rates. This would however, imply a modification in the PFA rules to permit the use of neutralisers in milk.

Separation of milk

Milk which is stale and partly sour or curdy, tends to lower the skimming efficiency largely because it increases the amount of separator slime which collects in the bowl and this in

turn impedes the free passage of milk and cream and causes excessive loss of fat (Hunziker, 1940). If the milk is on the verge of curdling, the chances of incomplete separation are augmented by the fact that each particle of curd looks up a small amount of fat and the curd passing into the skim milk on account of its higher sp. gravity, carries this fat with it. If it is necessary to run curdy milk through the separator, it should be stirred sufficiently to break up the curd as finely as possible; taking care to see that the separator is slightly underfed.

In some dairy plants, the sour milk is separated in the cold milk separator with poor skimming efficiency while at others it is neutralised and separated quite efficiently. Cream is used for ghee making and skim milk is converted into industrial casein with poor economic returns.

Concentrated milks

According to Hunziker (1949) the quality and marketable properties of every form of concentrated milk depends on the quality of the producer milk. The keeping quality of sweetened condensed milk is jeopardized by the high acidity of fresh milk. High acidity in the milk hastens the rate of age thickening in storage and increases the rapidity of the production of the sucrose inverting enzyme invertase which may lead to gaseous fermentation of sweetened condensed milk. An increase in acidity of fresh milk tends to give superheated condensed milk a grainy texture also.

For evaporated milk, ideally, milk should have no developed acidity, but the maximum acceptable range extends from 0·18 to 0·22 per cent, depending on initial titrable acidity (Hall and Hedrick, 1971). An increase in titrable acidity causes curdling trouble also in the sterilization operation.

Dried milk

High acidity has high acid flavour and the greater is the tendency towards curdling which appears in milk powder from fluid milk of high acidity. Long experience has shown (Fleming and Nair, 1921) that high acid milk taken in at the receiving platform continues to develop acidity so rapidly that milk powder derived from it has a peculiar disagreeable acid flavour, and will curdle easily on cooking. Further an increase in the acidity of the fresh milk augments the tendency of oxidation of milk fat, leading to tallowy flavour in whole milk powder, and it hastens the rate of denaturation of the milk protein causing a progressive decrease of the solubility of dried milks (Hunziker, 1949). Hall and Hedrick (1971) pointed out that drying affects a slight decrease in titrable acidity of the reconstituted product if the skim milk has become acidic.

Ice cream

A high acidity is undesirable in ice-cream mix as it contributes to excess mix viscosity, decreased whipping rate, inferior flavour, and a less stable mix resulting in "cook on" or possible coagulation during the pasteurising and processing procedure (Arbuckle, 1972). Such product gives extreme cold sensation on the tongue. The normal acidity of the ice-cream mix should be approximately 0·20 per cent. I.S.I. Standards (1964) indicate 0·25 per cent to be maximum acidity of ice-cream. So within this limit it may be possible to utilise some of the sour milk if the other ingredients of ice-cream are of good quality. But systematic work is required to explore the technical feasibility in the case.

Cheese

Schwartz and Mumm (1955) made Tilsit cheese from milk of 10°SH (44·4°SH=1%

lactic acid) acidity which had a crumbly chalky texture and a sour taste. Neutralization of milk to 8°SH with calcium hydroxide or sodium bicarbonate, or washing the curd improved both texture and taste, though cheese made with washed curd had a "Dutch" rather than a typical "Tilsit" aroma. Neutralization with tri-sodium phosphate was ineffective or detrimental. Cheese made with neutralized milk contained more calcium and less water and had a higher pH than cheese made with acid milk, but the differences were slight.

De *et al.* (1971) manufactured Paneer (soft cheese) from high acid milk having upto 0·28 per cent titrable acidity. The yield of soft cheese was on average 12 to 14 per cent lower than that obtained from fresh sweet milk and also the keeping quality of it was rather low being on an average of 1 to 2 days. However, the salted (at 1·5%) and sugared (at 15%) soft cheese remained wholesome for 3 to 4 days. These workers also suggested alternative uses of products, the salted paneer can be used for preparation of dried pakoras (with Bengal gram) or for cooked vegetable dish. It can also be used at 5% level in the preparation of processed cheese. The sugared cheese was directly consumable. The ground soft cheese can be mixed with spices (viz. ginger, corriander, etc.) at 5 per cent by weight and consumed as such.

Edible casein

Quite a good amount of interest has been shown in developing methods for the edible casein manufacture as compared to other products from sour milk. But the usual problems in such casein are its high fat content, free acidity and acid insoluble ash and lower protein contents. Bhanumurthi *et al.* (1972) claimed to have standardised a technique for preparing good quality edible casein from sour milk of about 0·18 per cent acidity. Deb (1969) reported that casein of good quality could be prepared from soured milk by treating it with warm water and churning it to separate the fat before precipitating the casein. Under All India Coordinated Research Project (1970-74) some studies have been done in this direction but full success has not been attained.

Realizing the need of the day, the senior author undertook a research project in 1977 to standardize the process of manufacture of edible casein from sour buffalo milk and study its various physico-chemical-sensory and keeping quality characteristics. The Protein Efficiency Ratio (PER) and toxicological studies need to be studied in depth with a further study of physico-chemical and functional properties of sodium and calcium caseinate prepared from such casein.

High fat products

Ghee is the most common product prepared uneconomically from sour/curdled milk. Curdled-milk, whenever received, is directly churned to butter and consequently heat clarified to ghee with very poor fat recovery. No systematic studies have been reported to increase the recovery of fat and also the ghee such prepared has not been studied for its physico-chemical, nutritional and sensory quality characteristics.

According to Hunziker (1949), the developed acidity hastens and intensified the reactions that lead to tallowy flavour. Even exceedingly small additions of acids barely perceptible to titration materially increased the susceptibility of the fat to oxidation. However, Holm and Greenbank demonstrated experimentally that partial removal of fatty acids by washing improved the keeping quality of the fat, and that steam distillation was effective in retarding fat oxidation.

Khoa and chhana

Physical quality of chhana also is adversely affected with the developed acidity of milk. Chhana from such milk tends to acquire a slight sour flavour and coarse texture.

Khoa of Danedar variety from high acidity milk has been prepared with full granular structure at National Dairy Research Institute, Karnal. Fresh sweet milk gives best quality product, while developed acidity in milk progressively tends to produce undesirable sour flavour and coarse texture in Khoa, which is thereby rendered unsuitable for sweet preparations (De and Tyagi, 1972). Neutralization or stabilization of acid milk improves the texture, but does not improve the flavour of khoa made.

Conclusion

Scope of utilization of sour milk for indigenous products seems to be greater, but it requires planned research to explore the technical feasibilities. As these products are prepared even on small scale in homes, the technical feasibility developed by research would be of great help for a number of housewives.

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